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A METHOD FOR REMOTE MEDICAL MONITORING AND EARLY DETECTION OF HEALTH DISORDERS

DESCRIPTION

TECHNICAL AREA

[0001] The present invention relates to a method for medical monitoring and early detection of health disorders over long distances by the measurement, transmission and evaluation of medically relevant data and institution as required of follow-up activities, such as notification of care staff, medical emergency facilities etc.

DEFINITIONS

[0002] Here and in the following, the term "communication" is understood to mean the transmission of information of any kind (e.g. measurement data, program data, control parameters or a signal in any other form) from at least one device to at least one other device. The transmission of data may be mono- or bidirectional and may occur in duplex or simplex mode. The term "communication" further includes any type of known transmission process, including electromagnetic radiation, (radio waves, light, infrared radiation, etc.) compression waves (e.g. ultrasound) and contact-conditioned transmission techniques (power cord, laser waveguide, etc.).

[0003] The term "telecommunications network" is used to describe any arrangement of communications equipment (e.g. transmitter, receiver, repeater, etc.) and data transmission facilities (e.g. radio links, fibre optics or power cords etc.) that enable communication over long distances (e.g. across a building, across a region, across a country, between countries, or worldwide, including in air travel) and are known previously in their respective

applications. The term "telecommunications network" also explicitly includes wireless telephones (e.g. DECT), mobile wireless networks (GSM, UMTS, etc.), the Internet, energy grids, fibre optic cable networks, satellites, etc.

PRIOR ART

[0004] A few methods for monitoring health and transmitting measurement values or equivalent parameters to a monitoring or observation station are known. On the one hand, medical monitoring of immobile patients, such as is normally practised in hospitals (intensive care unit, etc.), is well known. By the nature of the system, this type of medical monitoring is only suitable for medical monitoring over short distances, for instance in one or more rooms and generally requires that the patient is at rest. These systems are therefore ineffective when medical monitoring and early detection of health disorders is needed at greater distances (e.g. across a building, across a region, across a country or even internationally).

[0005] On the other hand, there are systems that allow patients to be monitored even as they move about. In such cases, certain sensors must be attached to the patients at all times or as needed, for example according to a schedule or when the patient feels certain symptoms. The measurement data is then transmitted to a recipient either directly, for example immediately by telephone, or later, e.g. via the Internet. This recipient may be the responsible physician of a central office where the data is recorded, administered or forwarded to expert personnel for evaluation. Examples of such equipment are the "CARDIAX PC-EKG" produced by MESA GmbH or Imed Ltd. (see also US 5,876,351, Rohde), the "Tele-EKG" produced by TeleCare (see also US 5,841,846, Abbruscato), or the "RhythmCard" produced by Medi AG, to name but a few.

[0006] However, all the systems listed have the following drawbacks: they lack the capability of receiving patient data automatically at regular intervals and subjecting it to an automated pre-evaluation that is able to trigger certain responses independently. Such actions include for instance automatic requesting of further measurements, which may be taken without the active involvement of the patient, automatic notification of care staff or emergency facilities, automatic call-back of patients to check certain evaluation results and similar cases. The fact that previous systems require an active response on the part of the patient limits both the reliability of such methods - for example in cases where the patient is no longer capable of making such contact - and the ability of patients to change their location at will since they required access to certain communications infrastructures depending on the system.

[0007] In US 4,958,645, Cadell et al. (CME Telemetrix, Inc.) describe a multichannel digital medical telemetry system for defined areas within which a patient may move about. This requires that "patient locator transmitters" that are able to transmit (particularly ultrasonic) signals to locate the patient be installed throughout the area in which the patient is assumed to be moving. The telemetry system worn by the patient receives the locating data and transmits them to a receiver via an aerial.

[0008] One significant disadvantage of this concept is the enormous effort involved in setting up the locator devices, which also significantly limits the area that can be covered. A wide-area communication system that is capable of locating the patient - for example via a global positioning system (GPS) - does not yet exist.

[0009] US 6,047,203 (Sackner et al.) describes a non-invasive physiological monitoring system ("LifeShirt" or

"NimShirt": non invasive monitoring shirt, produced by LifeShirt.com) which includes communication means as well as sensors attached to the patient's body to transmit physiological signals to a recording/alarm unit. The alarm unit is able to relay pre-programmed voice instructions to the patient and/or to a health provider.

[0010] However, the system described in US 6,047,203 also suffers from certain limitations: it does not include the capability of automated medical pre-evaluation with instructions for the responsible physician, nor does it address the need to be able to locate the patient. A direct alarm signal to care personnel on site or notification of emergency facilities (physician, ambulance, etc.) was also omitted. If patients move outside of a known area, according to the system described by Sackner et al. as well, they are then forced to rely entirely on performing relayed instructions. Emergency medical care at the location is not assured with absolute certainty since the location of the patient is not known if the patient himself is not capable of providing that information.

[0011] The object of an automated method for remote medical monitoring and early detection of health disorders is therefore to overcome the limitations outlined in the aforegoing.

ADVANTAGES OF THE INVENTION

[0012] The method according to the invention incorporates the measurement, transmission and automated evaluation of medically relevant data and for instituting follow-up activities as needed, such as notification of care staff, medical emergency facilities etc. The data is collected by sensors that are attached to the patient's body. To protect personal privacy, this data is sent to a medical evaluation and monitoring point in discrete or encrypted form. Here,

the arriving data is processed automatically and analysed against certain algorithms with reference to earlier measurement data received from the respective patients and to data relating specifically to the person and his or her individual medical history (longitudinal view), i.e. it is subjected to automatic pre-evaluation (for the purposes of the medical evaluation and monitoring point, the terms "analysis" and "pre-evaluation" are used interchangeably). Analyses among patients (transverse) are also possible, making it possible for example to obtain comparative values from several patients. This kind of pre-evaluation of data in a complex system with a large number of measurement values is unprecedented.

[0013] Of course, this pre-evaluation only represents notes for the physician; while it cannot replace diagnosis by a medical professional, it does render the diagnosis considerably easier, enabling as it does a broad-based "check" of various interpretation options at the proven speed of modern data processing. The physician is still responsible for making the correct diagnosis. At the same time, in certain emergency situations the appropriate specialists may already be supplied with measurement values automatically and guided directly to the patient (e.g. ambulance etc.). This all represents a significant advance with respect to the prior art.

[0014] The principal advantages of this method are firstly the monitoring of and existing health conditions and the remote diagnosis of changes in those conditions, as well as early detection of possible health disorders based on initial symptoms, even before more serious complications occur, and secondly the capability to locate patients and provide medical assistance as quickly as possible. For example, patients with heart disorders may be warned of over-exertion in good time, before the danger becomes acute. This ensures timely warning of acute risks or

incipient disease. Moreover, the method assures location-based monitoring of patients, enables a more substantial personal database to be compiled than has been usual hitherto for purposes of medical decision making, and at the same time opens the possibility of a systematic long-term examination with individually adapted sensor configurations. It also makes it possible to provide the patient with emergency help in situ. The method according to the invention - including all of the measures described in the preceding - thus enables significantly more efficient provision of health care than was provided with the prior art.

[0015] The associated system includes sensors for measuring relevant data (including GPS if required), and also a home test kit as required for analysing samples at the site, telecommunications equipment based on telecommunications networks, and at least one evaluation point for the automatic pre-evaluation of measurement data and for notifying technical staff and care or emergency facilities.

[0016] Besides its use in monitoring people of advanced age or who require medical care, and athletes, the method according to the invention is also suitable for monitoring the health of people whose activities expose them to particular health risks or who have special responsibility for the safety of others by virtue of their professional duties (e.g. aircraft pilots, lorry, bus or train drivers or ship's crews, nuclear power station employees, deployed soldiers (e.g. United Nations peacekeeping missions) etc.

[0017] For this, means are used that enable communication over long distances, i.e. "everywhere", including throughout a building (e.g. hospital, nursing home), across a country (e.g. in urban or rural areas, or hilly terrain), internationally or worldwide (e.g. intercontinental) including airspace and oceans. The means required for such

are devices known in their respective fields, for example devices for communication in buildings include wireless telephones (e.g. DECT) etc., as well as mobile wireless networks (GSM, UMTS, etc), the Internet, energy supply grids, fibre optic cable networks, satellites, etc.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0018] In a preferred configuration, the method according to the invention includes the measurement of medically relevant data by suitable sensors via personal sensor packs (PSPs), which include sensors in an array designed specifically to meet the individual requirements of the patient. This individual configuration may include a GPS device in addition to the sensors for measuring medically relevant variables such as pulse, heart rate/EKG, blood pressure, body temperature, blood oxygen level, blood circulation in tissue, optical/thermal imaging etc.

[0019] In a preferred variant of this configuration, these PSPs are equipped with means for communicating with at least one medical evaluation and monitoring point. To protect personal privacy, this communication is encrypted (here and in the following, encrypted data also means discrete or randomised). Together with the communication means, the PSPs form the personal sensor units (PSUs). PSUs enable the output of visual, acoustic, if necessary even tactile messages and direct input of data via keys, a microphone or other conventional method.

[0020] In a refinement of the configuration of this method, a home test kit (HL) is also used, and is quite simple to operate by the patient, enabling regular examinations of samples from the patient (e.g. blood, urine, tidal volume, perspiration, saliva, stool, hair even hormone samples) in addition to the respective PSU.

[0021] In a preferred variant of this configuration, this home test kit is also equipped with means for encrypted communication with the medical evaluation and monitoring point. In combination, the HL and the communications means form a home test kit unit (HLU).

[0022] For both configurations of the method the PSU or HLU passes encrypted communications to the medical evaluation and monitoring point via one or perhaps several different telecommunications networks (TN). Communication between the PSU and the HLU is also provided, in which case the HLU may also function as a relay station for communications between the PSU and the medical evaluation and monitoring point. The data arriving at the medical evaluation and monitoring point is processed by a "medical diagnostic central computer" (MDCC) and analysed against certain algorithms (pre-evaluation). This analysis is conducted longitudinally (relating to one specific patient) i.e. with reference to earlier measurement data received from the respective patients and to data relating specifically to the person and his or her individual medical history. The analysis of the incoming data may also be performed transversely (relating to other patients), i.e. the measurement values recorded are compared with measurement values, anonymous personal data or anonymous medical histories of other patients, when for example unusual isolated reactions may be taken into account. Additionally, the patients' location may also be considered, so that special circumstances such as the effects of acceleration in an aircraft, weather or climate-related influences, geographical surroundings (e.g. travel in hilly country) may also be included in the analysis.

[0023] Through the PSU, the MDCC is able to trigger further or more accurate measurements (e.g. at higher resolution) as determined by its programming and the results of analysis, to some degree even without the patient being

actively involved or even noticing the procedure. The MDCC is also able to question the patient (e.g. visually on a display or also acoustically via a loudspeaker) or to ask the patient to make additional measurements with the HLU. If an obvious medical emergency arises, the MDCC may use the GPS devices contained in the PSPs to determine the location of the patient and alert the appropriate institutions, for instance specially trained care staff, treating physicians or emergency facilities such as ambulances, etc. These may then be guided directly to the patient's current location. In all cases, the MDCC informs the duty medical staff at the medical evaluation and monitoring point if critical analysis results are detected so that they may also respond.

[0024] In a variation of the configurations described, a partial analysis of the data collected is carried out by the PSP or the HL, appropriate means being provided for such a case.

[0025] In a refinement of the method, the MDCC may include one or more computers and associated peripheral devices, in which case the combined system is termed the MDCC.

[0026] In a further refined configuration of the method, instead of one standalone MDCC preferably several "regional" MDCCs exist at respective medical evaluation and monitoring points in various regions, thereby achieving the largest possible area coverage. The regional MDCCs in the various regions are connected in a network (for example via the Internet), in which one regional MDCC may assume over the tasks of an MDCC that has failed in a neighbouring region for a brief or extended period. For this purpose, patient data is stored from one responsible regional MDSS is stored as a copy on a small number of defined neighbouring regional MDCCs, to ensure that a regional MDCC may take the place of a neighbouring MDCC that is

temporarily offline. To cope with area-wide failures of several neighbouring regional MDCCs, the patient data is stored on at least one distant regional MDCC in addition to the defined neighbouring regional MDCCs described.

[0027] In a further configuration of the method, the application is guaranteed "everywhere", including throughout a building (e.g. hospital, nursing home, power station), across a country (e.g. in urban or rural areas, or hilly terrain), internationally or worldwide (e.g. intercontinental), including on streets, in the air and on oceans as well as in the corresponding means of transport (cars, trains, ships, aircraft, etc.). The means required for such are devices known in their respective fields, for example devices for communication in buildings such as wireless telephones (e.g. DECT) etc., as well as mobile wireless networks (GSM, UMTS, etc.), the Internet, energy supply grids, fibre optic cable networks, satellites, etc.

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ABSTRACT

A method is described for remote medical monitoring and early detection of health disorders by the measurement, transmission and evaluation (longitudinal or transverse) of medically relevant data and for instituting follow-up activities, such as notification of care staff, medical emergency facilities etc. The system includes sensors for measuring relevant data, also a home test kit as required for sample analysis, telecommunications equipment based in telecommunication networks and at least one evaluation point for the measurement data. The method is suitable for use anywhere, for example in buildings, in urban or rural locales, in hilly terrain or in vehicles such as cars, trains, aircraft, ships, etc. Besides monitoring people of advanced age or who require medical care, and athletes, the method is also suitable for monitoring the health of people whose activities expose them to particular health risks or who have special responsibility for the safety of others by virtue of their professional duties (e.g. aircraft pilots, lorry, bus or train drivers or ship's captains, nuclear power station employees, deployed soldiers etc.).